

# NEC

## NPN SILICON HIGH FREQUENCY TRANSISTOR

### NE662M16

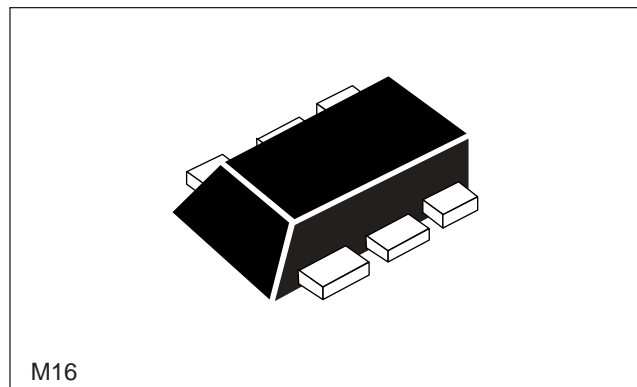
### FEATURES

- **HIGH GAIN BANDWIDTH:**  $f_T = 25 \text{ GHz}$
- **LOW NOISE FIGURE:**  $NF = 1.1 \text{ dB}$  at  $2 \text{ GHz}$
- **HIGH MAXIMUM STABLE GAIN:**  $20 \text{ dB}$  at  $f = 2 \text{ GHz}$
- **NEW LOW PROFILE M16 PACKAGE:**
  - Flat Lead Style with a height of just  $0.50\text{mm}$

### DESCRIPTION

The NE662M16 is fabricated using NEC's UHS0 25 GHz  $f_T$  wafer process. With a typical transition frequency of 25 GHz the NE662M16 is usable in applications from 100 MHz to over 10 GHz. The NE662M16 provides excellent low voltage/low current performance.

NEC's new low profile/flat lead style "M16" package is ideal for today's portable wireless applications. The NE662M16 is an ideal choice for LNA and oscillator requirements in all mobile communication systems.



### ELECTRICAL CHARACTERISTICS (TA = 25°C)

PART NUMBER EIAJ <sup>1</sup> REGISTERED NUMBER PACKAGE OUTLINE			NE662M16 2SC5704 M16			
SYMBOLS		PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX
DC	ICBO	Collector Cutoff Current at $V_{CB} = 5\text{V}$ , $I_E = 0$	nA			200
	IEBO	Emitter Cutoff Current at $V_{EB} = 1\text{V}$ , $I_C = 0$	nA			200
	hFE	Forward Current Gain <sup>2</sup> at $V_{CE} = 2\text{V}$ , $I_C = 5\text{mA}$		50	70	100
RF	$f_T$	Gain Bandwidth at $V_{CE} = 3\text{V}$ , $I_C = 30\text{mA}$ , $f = 2\text{GHz}$	GHz	20	25	
	MSG	Maximum Stable Gain <sup>4</sup> at $V_{CE} = 2\text{V}$ , $I_C = 20\text{mA}$ , $f = 2\text{GHz}$	dB		20	
	$ S_{21E} ^2$	Insertion Power Gain at $V_{CE} = 2\text{V}$ , $I_C = 20\text{mA}$ , $f = 2\text{GHz}$	dB	14	17	
	NF	Noise Figure at $V_{CE} = 2\text{V}$ , $I_C = 5\text{mA}$ , $f = 2\text{GHz}$ , $Z_{IN} = Z_{OPT}$	dB		1.1	1.5
	P1dB	Output Power at 1 dB compression point at $V_{CE} = 2\text{V}$ , $I_C = 20\text{mA}$ , $f = 2\text{GHz}$	dBm		11	
	IP3	Third Order Intercept Point at $V_{CE} = 2\text{V}$ , $I_C = 20\text{mA}$ , $f = 2\text{GHz}$			22	
	Cre	Feedback Capacitance <sup>3</sup> at $V_{CB} = 2\text{V}$ , $I_C = 0$ , $f = 1\text{MHz}$	pF		0.14	0.24

Notes:

1. Electronic Industrial Association of Japan.
2. Pulsed measurement, pulse width  $\leq 350 \mu\text{s}$ , duty cycle  $\leq 2\%$ .
3. Capacitance is measured by capacitance meter (automatic balance bridge method) when emitter pin is connected to the guard pin.
4.  $MSG = \left| \frac{S_{21}}{S_{12}} \right|$

ABSOLUTE MAXIMUM RATINGS<sup>1</sup> (T<sub>A</sub> = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V <sub>CB0</sub>	Collector to Base Voltage	V	15
V <sub>CE0</sub>	Collector to Emitter Voltage	V	3.3
V <sub>EB0</sub>	Emitter to Base Voltage	V	1.5
I <sub>C</sub>	Collector Current	mA	35
P <sub>T</sub>	Total Power Dissipation	mW	115
T <sub>J</sub>	Junction Temperature	°C	150
T <sub>STG</sub>	Storage Temperature	°C	-65 to +150

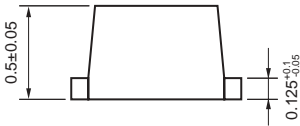
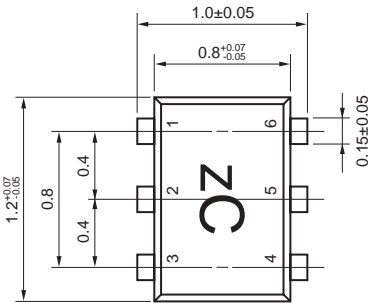
Note:  
1. Operation in excess of any one of these parameters may result in permanent damage.

ORDERING INFORMATION

PART NUMBER	QUANTITY	PACKAGING
NE662M16-T3	10 kpcs/reel	Pin 1 (Collector), Pin 6 (Emitter) face the perforation side on the tape.

OUTLINE DIMENSIONS (Units in mm)

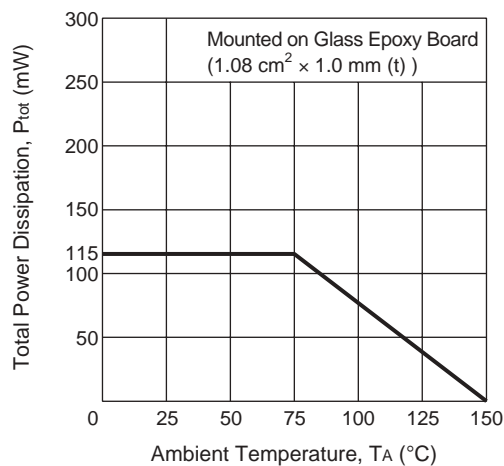
PACKAGE OUTLINE M16



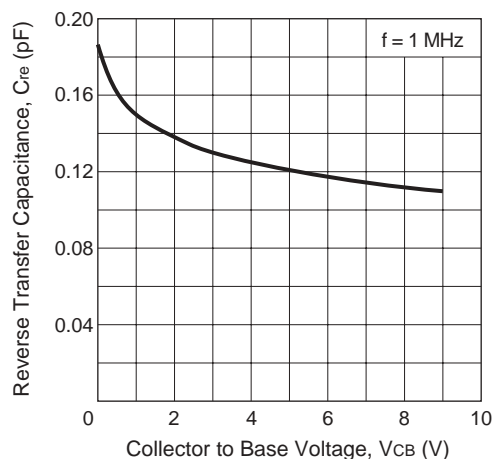
- PIN CONNECTIONS
- |              |            |
|--------------|------------|
| 1. Collector | 4. Base    |
| 2. Emitter   | 5. Emitter |
| 3. Emitter   | 6. Emitter |

# TYPICAL PERFORMANCE CURVES ( $T_A = 25^\circ\text{C}$ )

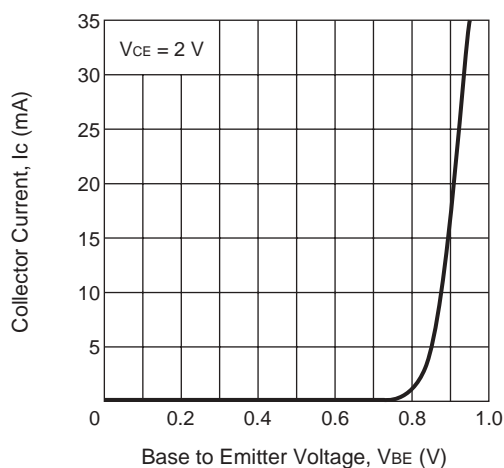
**TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE**



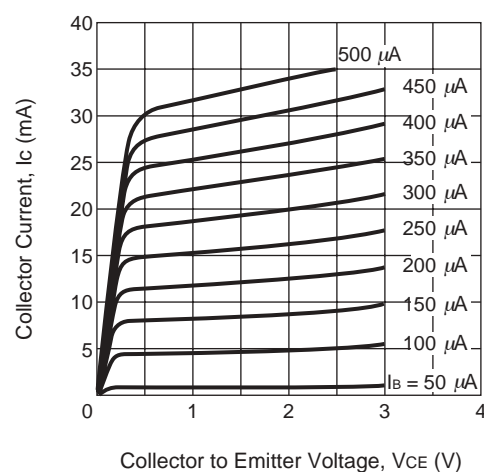
**REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE**



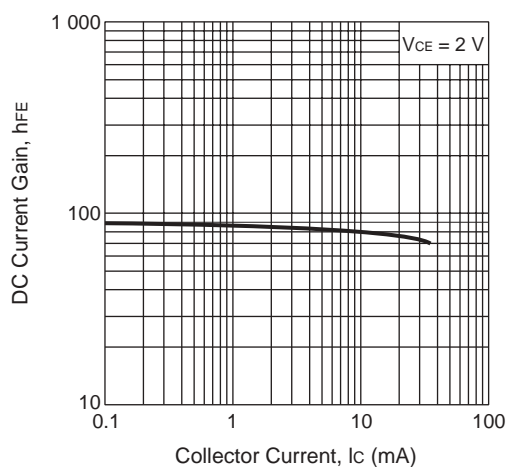
**COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE**



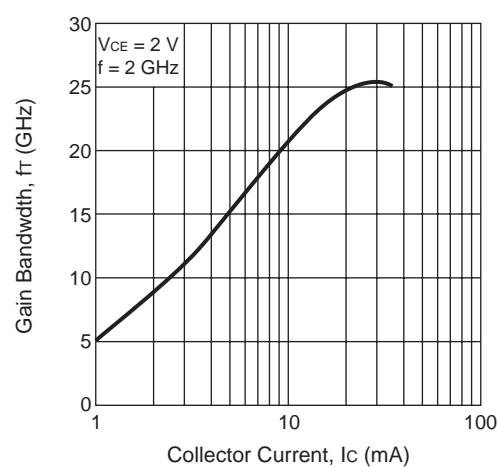
**COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE**



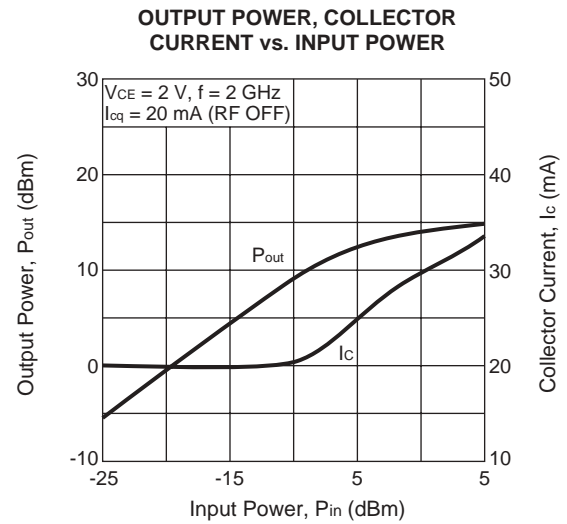
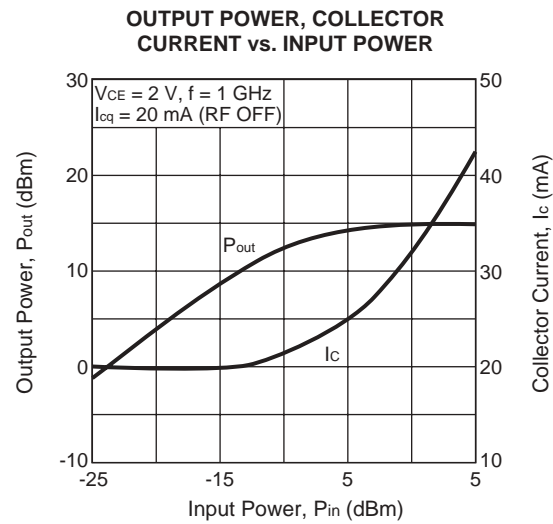
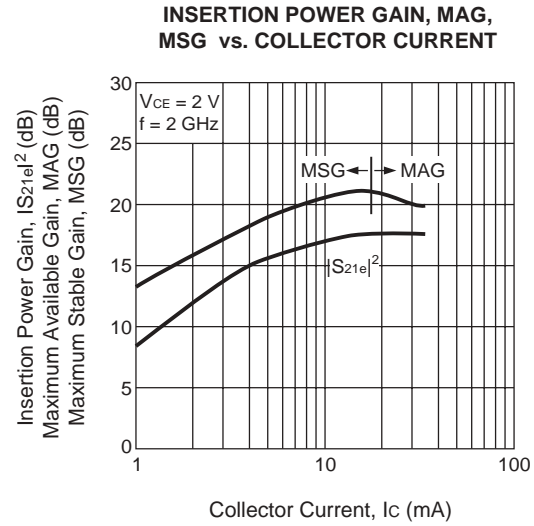
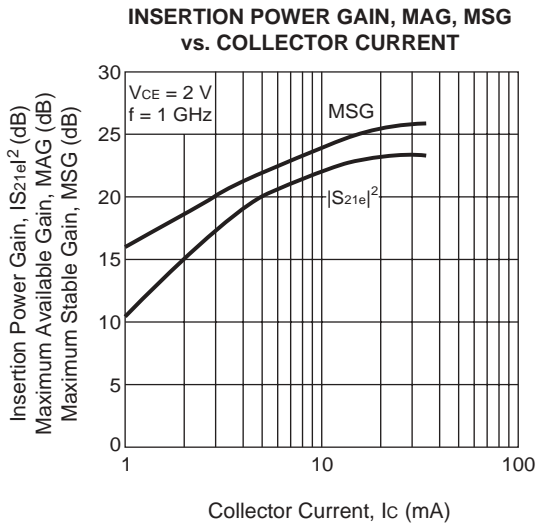
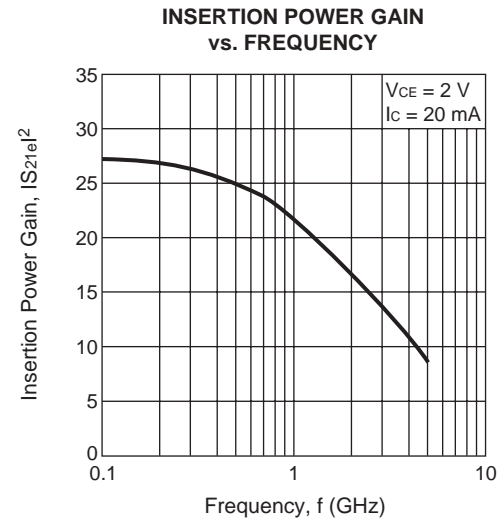
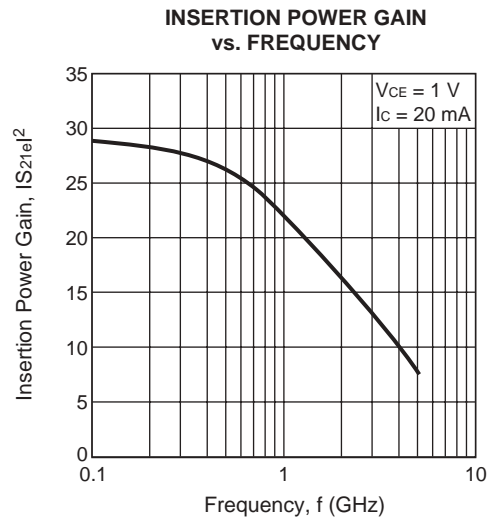
**DC CURRENT GAIN vs. COLLECTOR CURRENT**

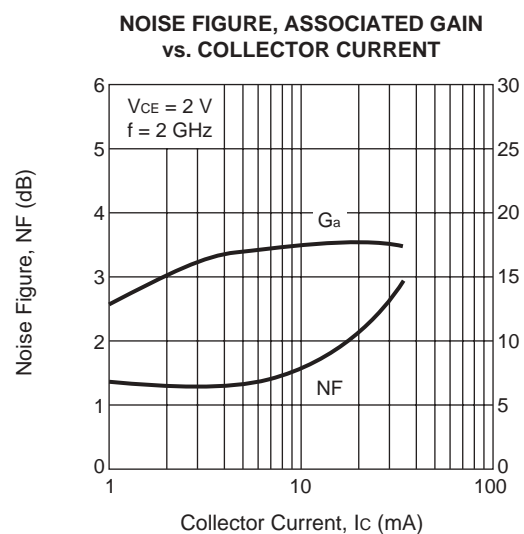
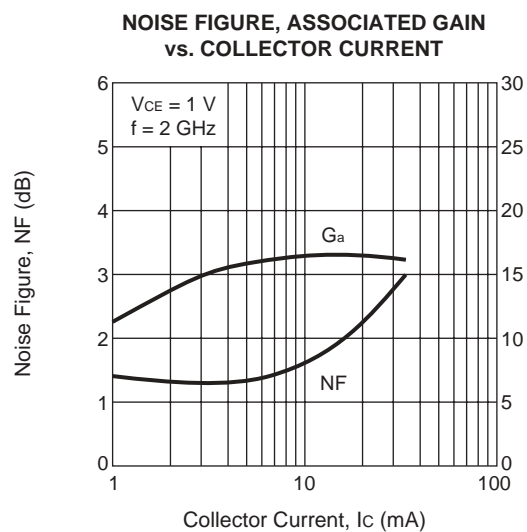
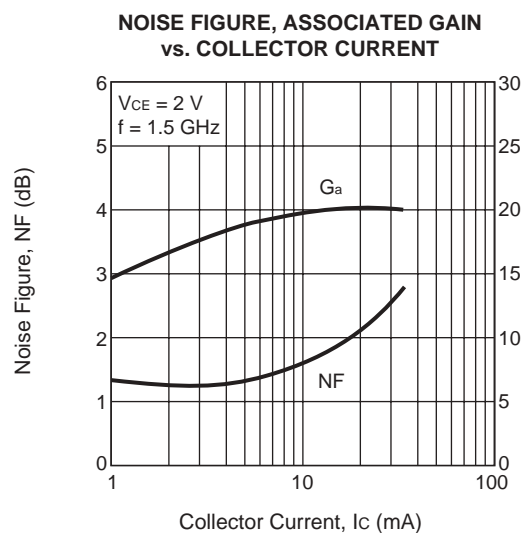
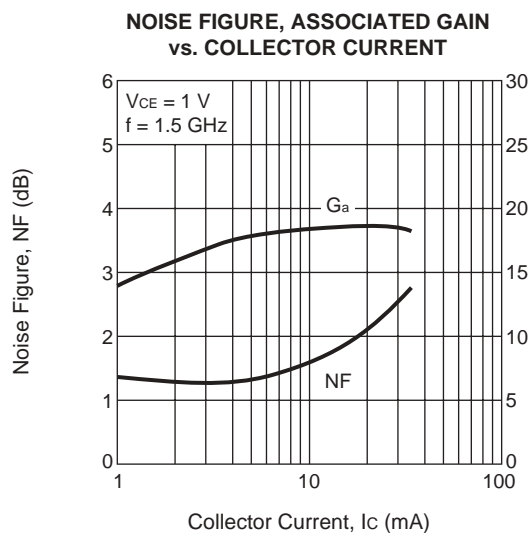
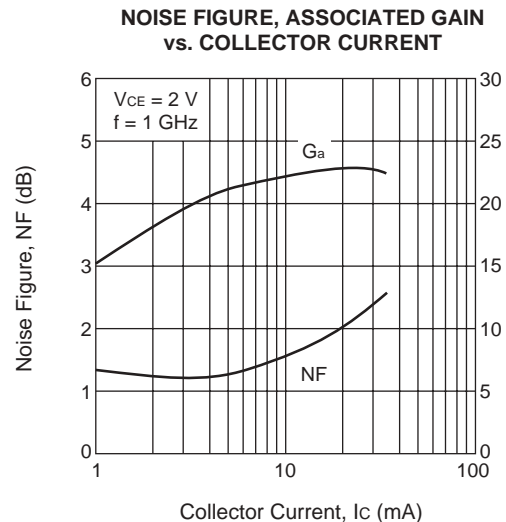
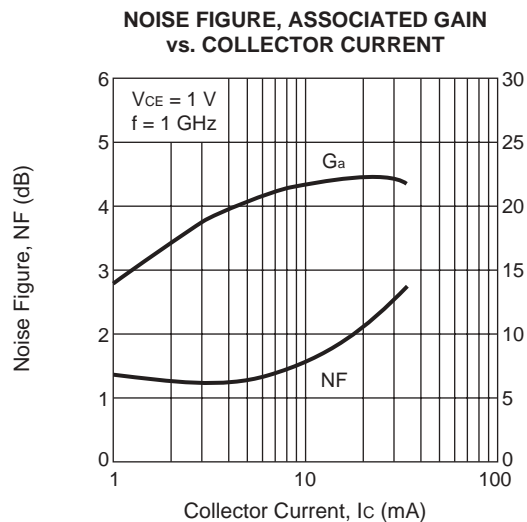


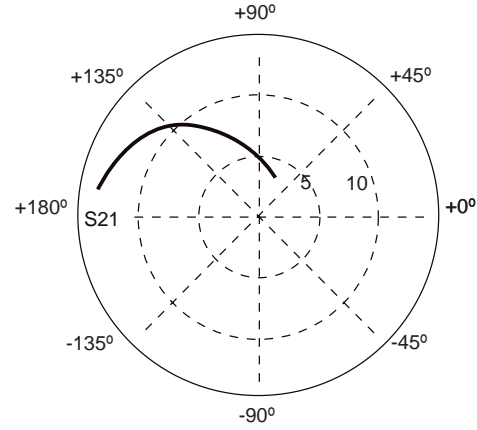
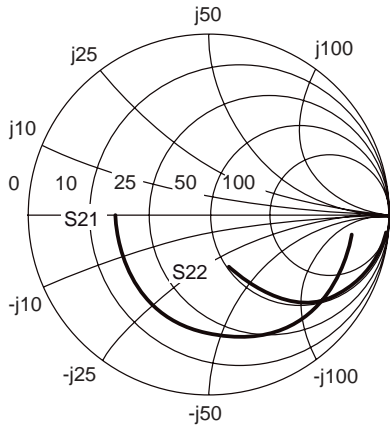
**GAIN BANDWIDTH vs. COLLECTOR CURRENT**



TYPICAL PERFORMANCE CURVES (T<sub>A</sub> = 25°C)



TYPICAL PERFORMANCE CURVES ( $T_A = 25^\circ\text{C}$ )

TYPICAL SCATTERING PARAMETERS (T<sub>A</sub> = 25°C)

## NE662M16

V<sub>c</sub> = 2 V, I<sub>c</sub> = 5 mA

FREQUENCY	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	MAG <sup>1</sup>
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.79	-8.34	13.52	171.32	0.01	84.69	0.98	-5.81	0.13	32.18
0.200	0.79	-20.52	13.20	165.06	0.02	78.92	0.96	-11.66	0.09	29.17
0.300	0.78	-30.77	12.77	158.29	0.02	73.38	0.93	-16.99	0.11	27.36
0.400	0.76	-39.87	12.28	152.12	0.03	68.92	0.90	-21.91	0.14	26.09
0.500	0.74	-48.66	11.75	146.29	0.04	64.34	0.87	-26.38	0.17	25.11
0.600	0.73	-56.79	11.15	140.96	0.04	60.23	0.83	-30.37	0.20	24.28
0.700	0.71	-64.12	10.59	136.12	0.05	56.71	0.79	-33.94	0.24	23.60
0.800	0.69	-71.30	10.02	131.99	0.05	53.36	0.76	-37.10	0.26	22.99
0.900	0.68	-77.50	9.48	128.20	0.05	50.48	0.72	-39.91	0.29	22.47
1.000	0.66	-83.36	8.98	124.77	0.06	47.89	0.69	-42.40	0.32	21.99
1.100	0.65	-88.67	8.55	121.61	0.06	45.67	0.66	-44.60	0.35	21.59
1.200	0.64	-93.70	8.15	118.55	0.06	43.73	0.64	-46.56	0.38	21.22
1.300	0.64	-98.23	7.79	115.75	0.06	42.02	0.61	-48.38	0.40	20.88
1.400	0.63	-102.48	7.45	113.15	0.07	40.50	0.59	-49.89	0.43	20.57
1.500	0.62	-106.53	7.14	110.70	0.07	39.06	0.57	-51.38	0.46	20.28
1.600	0.61	-110.24	6.82	108.22	0.07	37.77	0.55	-52.58	0.49	19.99
1.700	0.60	-113.97	6.57	105.79	0.07	36.69	0.53	-53.71	0.52	19.74
1.800	0.60	-117.60	6.36	103.81	0.07	35.72	0.51	-54.81	0.55	19.54
1.900	0.59	-120.80	6.11	102.01	0.07	34.87	0.50	-55.74	0.58	19.31
2.000	0.58	-124.09	5.86	99.85	0.07	34.09	0.48	-56.51	0.61	19.06
2.100	0.58	-127.67	5.69	97.73	0.07	33.33	0.47	-57.44	0.64	18.89
2.200	0.57	-130.76	5.51	95.62	0.07	32.59	0.46	-57.89	0.66	18.68
2.300	0.57	-133.98	5.37	94.20	0.08	32.26	0.44	-58.61	0.68	18.53
2.400	0.56	-136.85	5.16	92.25	0.08	31.81	0.43	-59.18	0.71	18.31
2.500	0.56	-139.86	5.03	90.06	0.08	31.21	0.42	-59.83	0.74	18.17
2.600	0.55	-142.72	4.88	88.26	0.08	30.84	0.41	-60.32	0.77	17.98
2.700	0.55	-145.66	4.75	86.62	0.08	30.55	0.40	-60.89	0.80	17.83
2.800	0.54	-148.25	4.58	84.94	0.08	30.18	0.39	-61.28	0.83	17.63
2.900	0.54	-151.04	4.46	82.99	0.08	30.00	0.38	-61.71	0.87	17.50
3.000	0.53	-153.76	4.35	81.42	0.08	29.61	0.37	-62.28	0.90	17.34
3.100	0.52	-156.67	4.21	79.85	0.08	29.45	0.36	-62.64	0.93	17.17
3.200	0.52	-159.41	4.09	78.16	0.08	29.21	0.36	-63.08	0.96	17.02
3.300	0.52	-162.03	4.00	76.53	0.08	28.97	0.35	-63.54	0.99	16.88
3.400	0.52	-164.80	3.89	75.17	0.08	28.78	0.34	-64.05	1.02	15.94
3.500	0.51	-167.55	3.78	73.64	0.08	28.67	0.33	-64.59	1.05	15.28
3.600	0.51	-170.15	3.68	71.91	0.08	28.50	0.32	-65.11	1.07	14.77
3.700	0.51	-172.65	3.61	70.42	0.08	28.28	0.32	-65.78	1.09	14.44
3.800	0.51	-174.91	3.51	69.29	0.08	28.15	0.31	-66.41	1.12	14.02
3.900	0.51	-177.27	3.40	67.93	0.09	28.08	0.30	-67.07	1.16	13.59
4.000	0.51	-179.59	3.31	66.28	0.09	27.96	0.29	-67.74	1.19	13.22

Note:

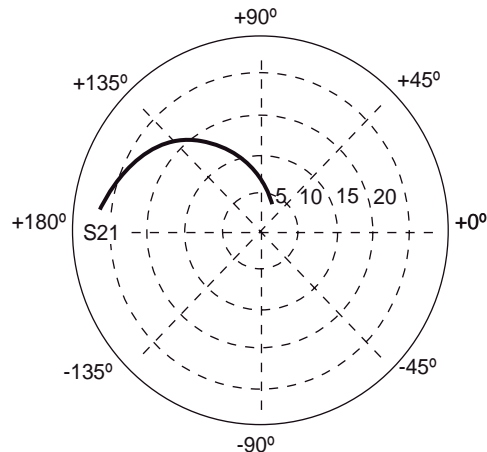
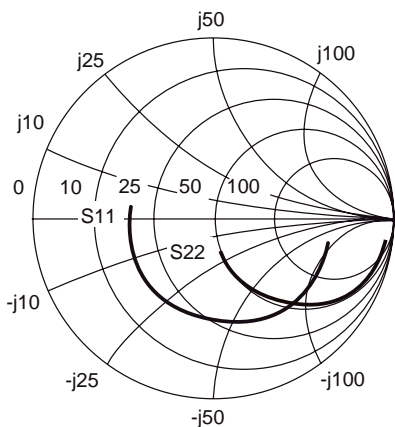
1. Gain Calculations:

$$\text{MAG} = \frac{|S_{21}|}{|S_{12}|} \left( K \pm \sqrt{K^2 - 1} \right). \text{ When } K \leq 1, \text{ MAG is undefined and MSG values are used. } \text{MSG} = \frac{|S_{21}|}{|S_{12}|}, K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}, \Delta = S_{11} S_{22} - S_{21} S_{12}$$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

# TYPICAL SCATTERING PARAMETERS (T<sub>A</sub> = 25°C)



## NE662M16

V<sub>c</sub> = 2 V, I<sub>c</sub> = 10 mA

FREQUENCY	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	MAG <sup>1</sup>
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.66	-12.81	21.08	170.08	0.01	81.45	0.96	-7.79	0.19	34.48
0.200	0.66	-28.48	20.34	161.46	0.01	76.90	0.94	-15.60	0.13	31.43
0.300	0.65	-41.93	19.32	153.18	0.02	70.56	0.90	-22.67	0.16	29.60
0.400	0.63	-53.87	18.18	145.93	0.03	65.20	0.85	-28.92	0.20	28.32
0.500	0.61	-64.70	16.97	139.38	0.03	60.63	0.80	-34.46	0.24	27.29
0.600	0.60	-74.41	15.75	133.63	0.04	56.67	0.75	-39.19	0.28	26.47
0.700	0.58	-82.86	14.65	128.64	0.04	53.54	0.70	-43.27	0.33	25.76
0.800	0.57	-90.61	13.62	124.38	0.04	50.71	0.66	-46.77	0.37	25.14
0.900	0.56	-97.18	12.70	120.59	0.04	48.39	0.62	-49.77	0.41	24.59
1.000	0.55	-103.22	11.88	117.23	0.05	46.60	0.58	-52.36	0.45	24.11
1.100	0.55	-108.53	11.17	114.18	0.05	45.17	0.55	-54.59	0.49	23.68
1.200	0.54	-113.37	10.51	111.31	0.05	43.92	0.52	-56.54	0.52	23.28
1.300	0.54	-117.69	9.95	108.65	0.05	42.92	0.50	-58.27	0.56	22.91
1.400	0.53	-121.63	9.43	106.24	0.05	42.14	0.47	-59.73	0.59	22.57
1.500	0.53	-125.35	8.96	103.96	0.05	41.39	0.45	-61.06	0.63	22.24
1.600	0.52	-128.85	8.50	101.70	0.05	40.83	0.43	-62.21	0.66	21.92
1.700	0.52	-132.25	8.13	99.47	0.06	40.51	0.42	-63.19	0.70	21.65
1.800	0.52	-135.50	7.82	97.63	0.06	40.23	0.40	-64.16	0.73	21.39
1.900	0.51	-138.46	7.48	96.05	0.06	39.88	0.38	-64.99	0.76	21.12
2.000	0.51	-141.58	7.14	94.06	0.06	39.77	0.37	-65.63	0.80	20.83
2.100	0.51	-144.72	6.89	92.12	0.06	39.58	0.36	-66.43	0.82	20.62
2.200	0.50	-147.54	6.66	90.21	0.06	39.38	0.35	-66.83	0.84	20.38
2.300	0.50	-150.41	6.44	88.94	0.06	39.49	0.34	-67.39	0.87	20.17
2.400	0.50	-153.04	6.17	87.15	0.06	39.53	0.33	-67.86	0.90	19.91
2.500	0.50	-155.65	5.98	85.19	0.06	39.40	0.32	-68.39	0.93	19.72
2.600	0.49	-158.30	5.80	83.57	0.07	39.29	0.31	-68.81	0.95	19.50
2.700	0.49	-160.91	5.61	82.16	0.07	39.33	0.30	-69.31	0.98	19.29
2.800	0.49	-163.29	5.40	80.62	0.07	39.31	0.29	-69.61	1.01	18.53
2.900	0.48	-165.82	5.24	78.93	0.07	39.52	0.28	-70.04	1.04	17.69
3.000	0.48	-168.40	5.09	77.50	0.07	39.41	0.27	-70.48	1.06	17.14
3.100	0.47	-171.02	4.93	76.12	0.07	39.56	0.27	-70.87	1.09	16.67
3.200	0.47	-173.52	4.78	74.60	0.07	39.47	0.26	-71.30	1.11	16.22
3.300	0.47	-175.90	4.66	73.12	0.07	39.46	0.25	-71.76	1.13	15.88
3.400	0.47	-178.39	4.53	71.93	0.07	39.49	0.24	-72.30	1.15	15.52
3.500	0.47	-179.16	4.39	70.55	0.07	39.50	0.24	-72.89	1.17	15.17
3.600	0.47	-176.86	4.27	69.00	0.08	39.45	0.23	-73.50	1.19	14.85
3.700	0.47	-174.73	4.18	67.66	0.08	39.36	0.22	-74.30	1.21	14.60
3.800	0.47	-172.77	4.06	66.70	0.08	39.24	0.22	-75.12	1.23	14.28
3.900	0.47	-170.80	3.93	65.49	0.08	39.22	0.21	-75.94	1.25	13.93
4.000	0.47	-168.82	3.83	63.99	0.08	39.15	0.20	-76.91	1.27	13.64

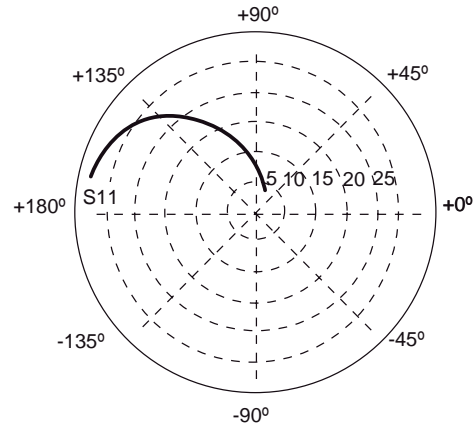
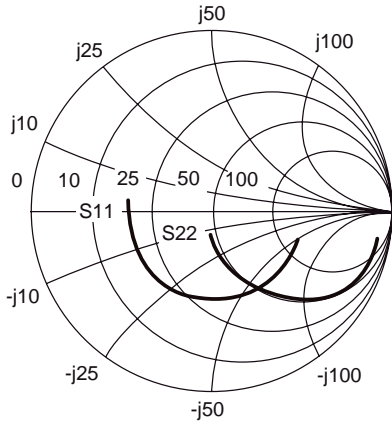
Note:

### 1. Gain Calculations:

$$\text{MAG} = \frac{|S_{21}|}{|S_{12}|} \left( K \pm \sqrt{K^2 - 1} \right). \text{ When } K \leq 1, \text{ MAG is undefined and MSG values are used. } \text{MSG} = \frac{|S_{21}|}{|S_{12}|}, K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}, \Delta = S_{11} S_{22} - S_{21} S_{12}$$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS (T<sub>A</sub> = 25°C)

## NE662M16

V<sub>c</sub> = 2 V, I<sub>c</sub> = 20 mA

FREQUENCY	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	MAG <sup>1</sup>
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.51	-19.24	28.64	168.38	0.01	79.10	0.94	-9.68	0.26	36.13
0.200	0.51	-39.58	27.18	157.71	0.01	74.03	0.90	-19.55	0.20	33.13
0.300	0.51	-56.67	25.27	148.17	0.02	67.79	0.85	-28.23	0.23	31.27
0.400	0.51	-71.47	23.19	140.08	0.02	62.44	0.79	-35.68	0.28	29.98
0.500	0.50	-83.85	21.13	133.18	0.03	58.17	0.72	-41.91	0.33	28.93
0.600	0.50	-94.44	19.22	127.33	0.03	54.93	0.66	-47.08	0.39	28.06
0.700	0.49	-103.20	17.57	122.40	0.03	52.50	0.61	-51.40	0.44	27.33
0.800	0.49	-110.77	16.11	118.27	0.03	50.56	0.56	-55.03	0.49	26.69
0.900	0.49	-117.07	14.85	114.65	0.04	49.13	0.52	-58.07	0.54	26.11
1.000	0.49	-122.58	13.76	111.47	0.04	48.10	0.49	-60.66	0.59	25.60
1.100	0.48	-127.34	12.83	108.63	0.04	47.35	0.46	-62.85	0.64	25.12
1.200	0.48	-131.56	11.98	105.97	0.04	46.96	0.43	-64.73	0.68	24.67
1.300	0.48	-135.30	11.27	103.49	0.04	46.65	0.41	-66.43	0.72	24.27
1.400	0.48	-138.62	10.62	101.28	0.04	46.44	0.39	-67.82	0.75	23.88
1.500	0.48	-141.83	10.04	99.19	0.04	46.48	0.37	-69.05	0.79	23.50
1.600	0.48	-144.87	9.49	97.12	0.05	46.28	0.35	-70.13	0.83	23.14
1.700	0.48	-147.80	9.04	95.06	0.05	46.44	0.33	-71.09	0.86	22.81
1.800	0.47	-150.55	8.66	93.37	0.05	46.55	0.32	-71.97	0.89	22.51
1.900	0.47	-153.08	8.25	91.95	0.05	46.81	0.31	-72.73	0.92	22.19
2.000	0.47	-155.81	7.86	90.10	0.05	46.88	0.29	-73.33	0.95	21.87
2.100	0.47	-158.52	7.56	88.29	0.05	46.96	0.28	-74.04	0.97	21.60
2.200	0.47	-161.02	7.29	86.54	0.05	47.15	0.27	-74.48	0.99	21.33
2.300	0.47	-163.41	7.03	85.38	0.05	47.44	0.26	-74.96	1.01	20.46
2.400	0.47	-165.69	6.72	83.75	0.06	47.56	0.26	-75.41	1.04	19.60
2.500	0.47	-167.97	6.50	81.93	0.06	47.55	0.25	-75.93	1.06	19.05
2.600	0.46	-170.37	6.29	80.42	0.06	47.65	0.24	-76.35	1.07	18.61
2.700	0.46	-172.58	6.07	79.19	0.06	47.79	0.23	-76.85	1.09	18.15
2.800	0.46	-174.73	5.84	77.76	0.06	47.81	0.22	-77.18	1.12	17.64
2.900	0.46	-177.01	5.65	76.22	0.06	47.96	0.21	-77.67	1.14	17.23
3.000	0.45	-179.36	5.49	74.88	0.06	47.89	0.21	-78.08	1.16	16.88
3.100	0.45	-178.28	5.31	73.63	0.07	48.00	0.20	-78.62	1.17	16.51
3.200	0.45	-176.08	5.14	72.22	0.07	47.97	0.19	-79.11	1.19	16.16
3.300	0.45	-173.87	5.00	70.83	0.07	47.81	0.19	-79.69	1.20	15.87
3.400	0.45	-171.68	4.86	69.75	0.07	47.81	0.18	-80.42	1.22	15.56
3.500	0.45	-169.53	4.71	68.47	0.07	47.78	0.18	-81.20	1.23	15.26
3.600	0.46	-167.47	4.58	67.03	0.07	47.68	0.17	-82.06	1.24	14.97
3.700	0.46	-165.67	4.47	65.80	0.07	47.46	0.16	-83.19	1.25	14.74
3.800	0.46	-163.96	4.34	64.93	0.08	47.30	0.16	-84.30	1.27	14.44
3.900	0.46	-162.28	4.21	63.80	0.08	47.24	0.15	-85.66	1.29	14.12
4.000	0.46	-160.56	4.09	62.37	0.08	46.96	0.15	-87.01	1.30	13.86

Note:

## 1. Gain Calculations:

$$\text{MAG} = \frac{|S_{21}|}{|S_{12}|} \left( K \pm \sqrt{K^2 - 1} \right). \text{ When } K \leq 1, \text{ MAG is undefined and MSG values are used. } \text{MSG} = \frac{|S_{21}|}{|S_{12}|}, K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}, \Delta = S_{11} S_{22} - S_{21} S_{12}$$

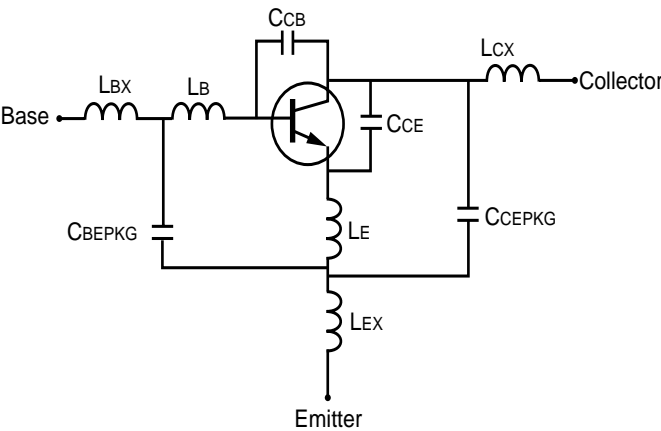
MAG = Maximum Available Gain

MSG = Maximum Stable Gain



NE662M16 NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS <sup>(1)</sup>

Parameters	Q1	Parameters	Q1
IS	1.6e-16	MJC	0.3
BF	105	XCJC	0.1
NF	1.02	CJS	0
VAF	23	VJS	0.75
IKF	0.38	MJS	0
ISE	1e-6	FC	0.6
NE	30	TF	2e-12
BR	12	XTF	0.2
NR	1.02	VTF	0.2
VAR	2.5	ITF	0.03
IKR	0.1	PTF	0
ISC	3e-15	TR	1e-11
NC	1.28	EG	1.11
RE	1.1	XTB	0
RB	6	XTI	3
RBM	3.5	KF	0
IRB	1.3e-3	AF	1
RC	8.75		
CJE	0.4e-12		
VJE	0.6		
MJE	0.5		
CJC	0.1e-12		
VJC	0.75		

ADDITIONAL PARAMETERS

Parameters	NE662M16
CCB	0.07e-12
CCE	0.09e-12
LB	0.4e-9
LE	0.14e-9
CCEPKG	0.12e-12
CBEPK	0.1e-12
LBX	0.1e-9
LCX	0.6e-9
LEX	0.04e-9

MODEL RANGE

Frequency: 0.1 to 4 GHz  
Bias: VCE = 0.5 V to 3 V, IC = 1 mA to 30 mA  
Date: 01/15/2002

(1) Gummel-Poon Model

Life Support Applications  
These NEC products are not intended for use in life support devices, appliances, or systems where the malfunction of these products can reasonably be expected to result in personal injury. The customers of CEL using or selling these products for use in such applications do so at their own risk and agree to fully indemnify CEL for all damages resulting from such improper use or sale.